

Study of $K_L \rightarrow \pi e \bar{\nu}_e$

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Things to do at end of previous presentation

- Fixing the problem in crunch
 - Made Progress , but a puzzle remains
- Systematic uncertainties analysis
 - Done first try for Ke3ee
- Other new things
 - Made Library of I2M Ke3ee events
 - Considering Ke3 as a BG

Trigger 4, NZF002~038

For both Ke3ee (singal)
and pm0dal (normalization)

- 3V_TIGHT * 2DC12_MED * ET_THR1
* !MU2 * PHVBAR1* 34HCY *
HCC_GE2 * YTFUDO * HC2XDUM
- '97 winter (NZF002~NZF038)

Nominal Cuts for Ke3ee

$22 \text{ GeV}/c^2 < E_{\text{Kaon}}(\text{min}), E_{\text{Kaon}}(\text{max}) < 210 \text{ GeV}/c^2$
$95 \text{ m} < \text{VertexZ} < 150 \text{ m}$
$\text{Vertex } \chi^2 < 40$
$0.925 < E/p < 1.075$ for electron tracks
$E/p < 0.9$ for pion tracks
TRD probability < 0.02 for electron tracks
TRD probability > 0.1 for pion tracks
$M_{\text{pieee}} < 0.5 \text{ GeV}/c^2$
$M_{e^+e^-} > 0.005 \text{ GeV}/c^2$
$p_{\text{pp0kine}} < -0.002 (\text{GeV}/c)^2$
$Ee^\pm(\text{Ke3}) > 10 \text{ GeV}$
$Ee^\pm(\text{pair}) > 1.5 \text{ GeV}$

Background Study

	N/S(%)
$K_L \rightarrow \pi^\pm e^\mp \nu \pi_D^0$	147±4 1.7
$K_L \rightarrow \pi^\pm e^\mp \nu \gamma$ ($\gamma \rightarrow e^+ e^-$, external) $K_L \rightarrow \pi^\pm e^\mp \nu$ external Brem. $\gamma \rightarrow e^+ e^-$, external)	28±10 0.33
$K_L \rightarrow \pi^\pm \pi^\mp \pi^0$ ($\pi^0 \rightarrow e^+ e^- e^+ e^-$)	14.5±2.4 0.17
$K_L \rightarrow \pi^\pm \pi^\mp \pi_D^0$	20±5 0.23

I used authentic KTeV MC, except for Ke3 and radiative Ke3.

For Ke3 and radiative Ke3,

1) only conversion events was traced.

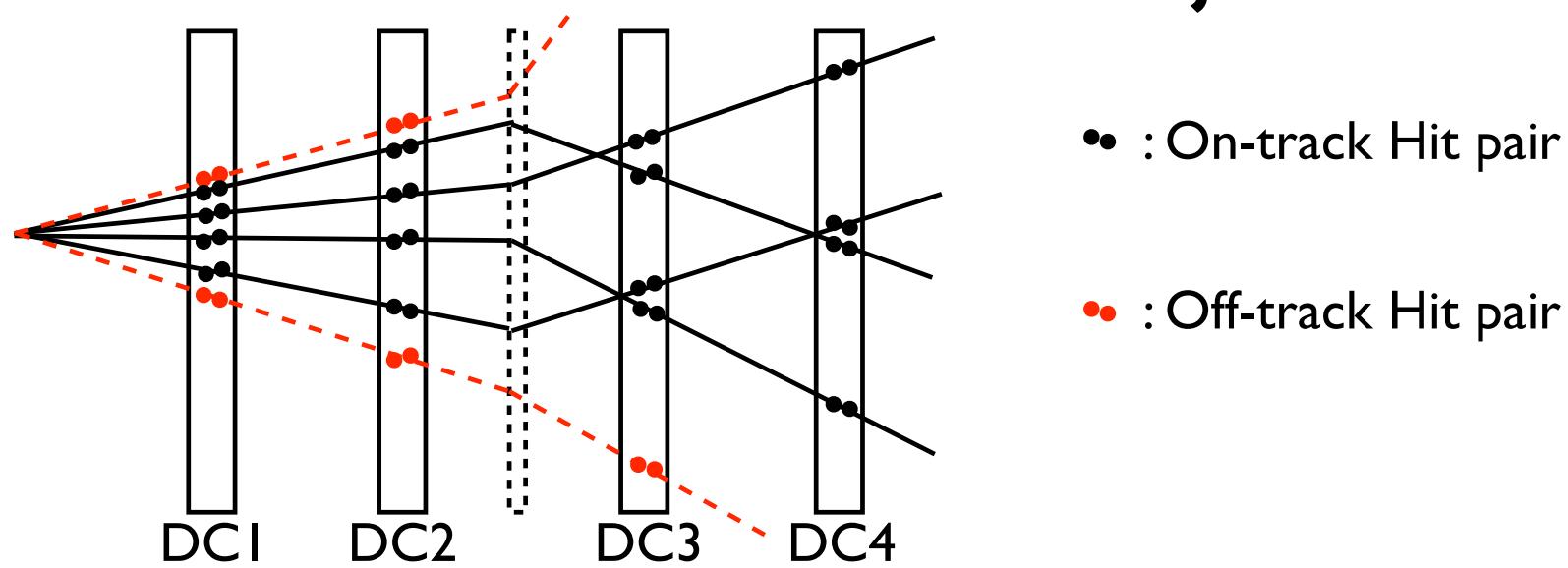
2) conversion probability was multiplied by factor 10

---> # of conversion event was normalized by # of conversion event in non-multiplied-probability generation.

Background Study

Strategy to remove	
$K_L \rightarrow \pi^\pm e^\mp \nu \pi_D^0$	-
$K_L \rightarrow \pi^\pm e^\mp \nu \gamma$ ($\gamma \rightarrow e^+ e^-$, external) $K_L \rightarrow \pi^\pm e^\mp \nu$ external Brem. $\gamma \rightarrow e^+ e^-$, external)	$M_{ee} > 5\text{MeV}$
$K_L \rightarrow \pi^\pm \pi^\mp \pi^0$ ($\pi^0 \rightarrow e^+ e^- e^+ e^-$)	Off-Track In time pair
$K_L \rightarrow \pi^\pm \pi^\mp \pi_D^0$	p0, E/p, TRD

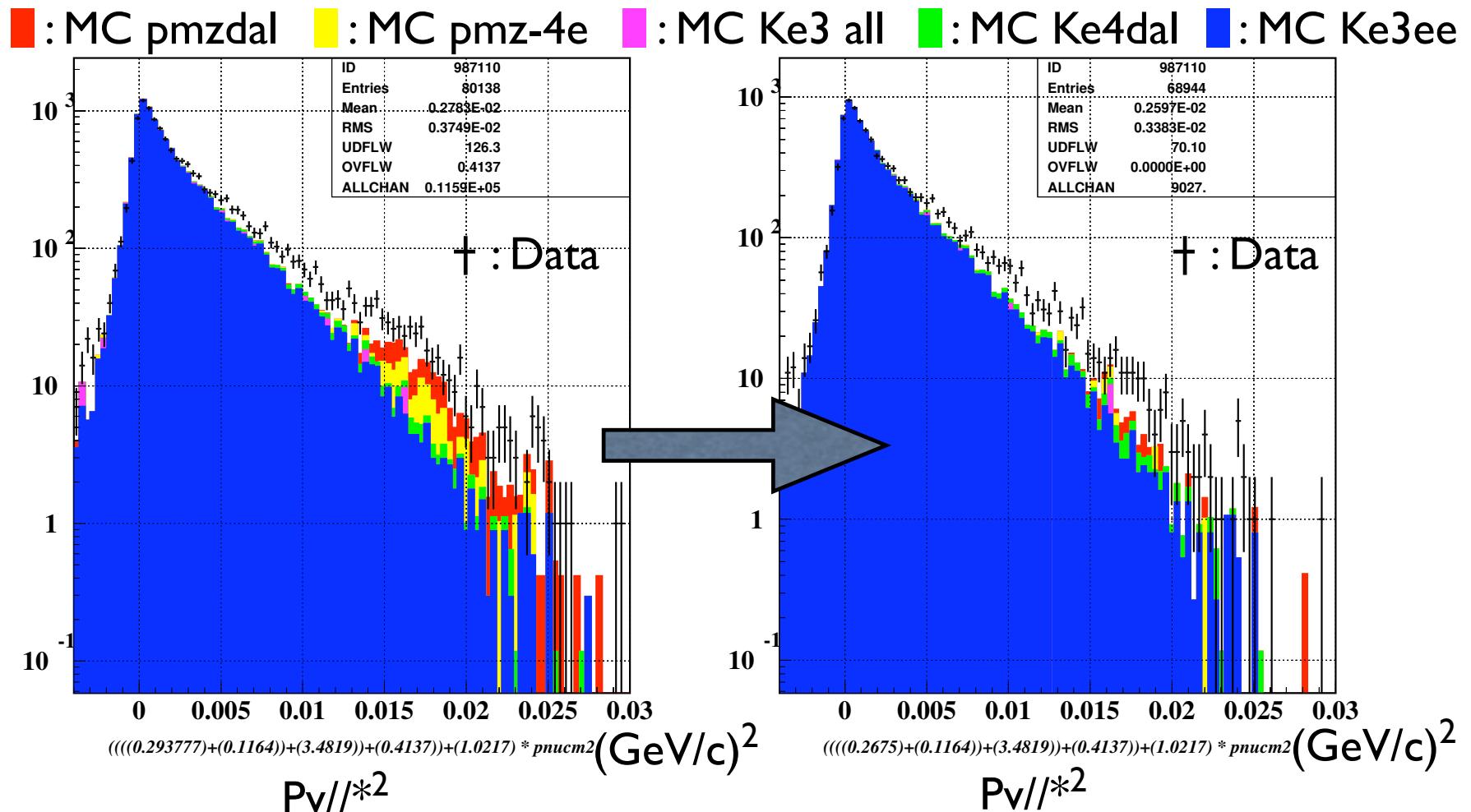
Off-track In Time Pair Rejection



		Signal	pmz4e	B/S(%)
	No Off-Track pair cut	11360	97.6	0.86
Cut farther than 1 cell from track	DC2(x view only)	10508	37.6	0.36
	DC2(x,y both view)	9849	24.4	0.24
	DC1*DC2(x,y both view)	8571	18.2	0.21
	DC2*DC3(x,y both view)	8768	14.5	0.17
1.5 cell	DC2*DC3(x,y both view)	8972	17.4	0.19

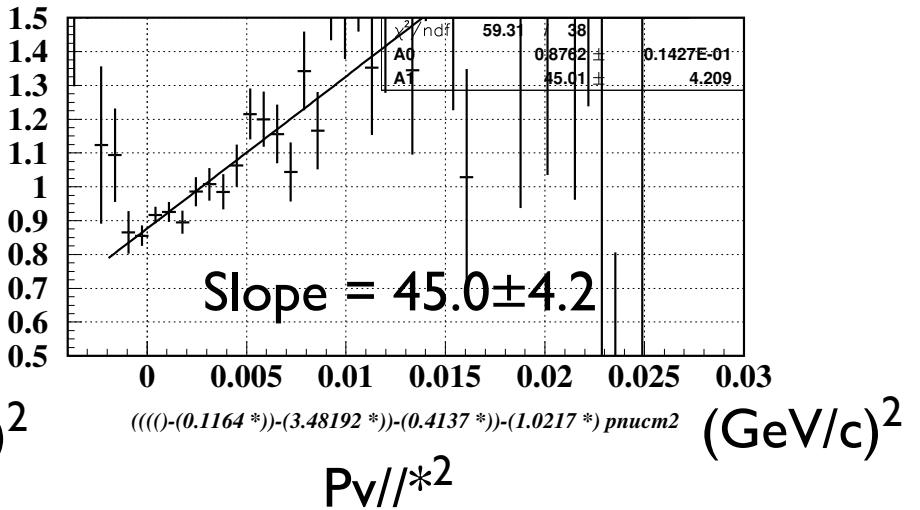
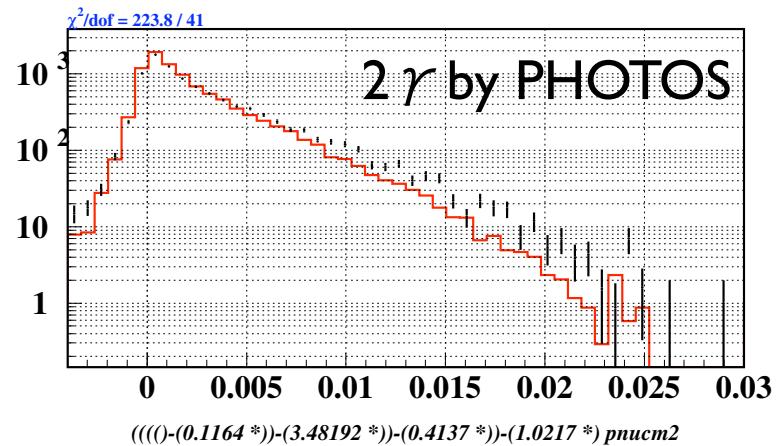
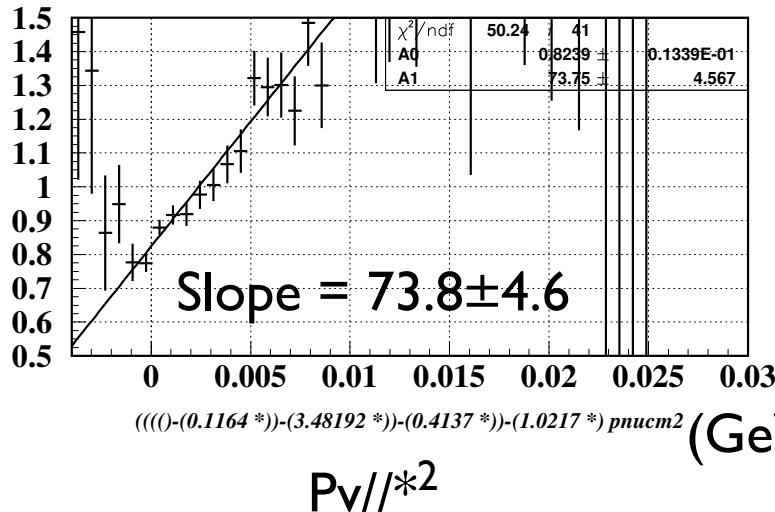
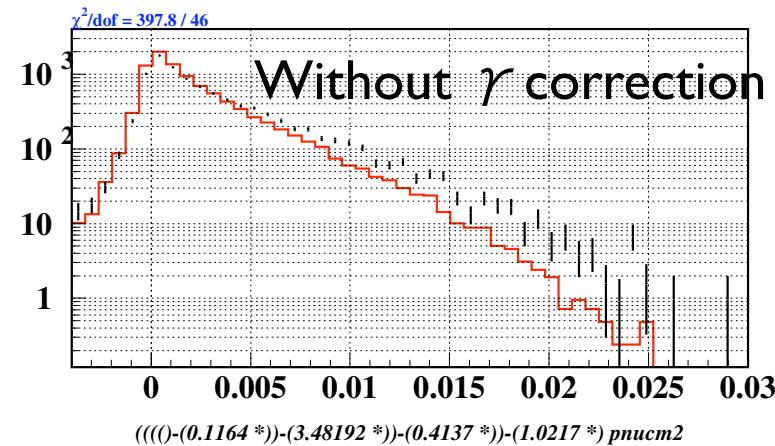


Off-track In Time Pair Rejection



Difference still remains between Data and MC

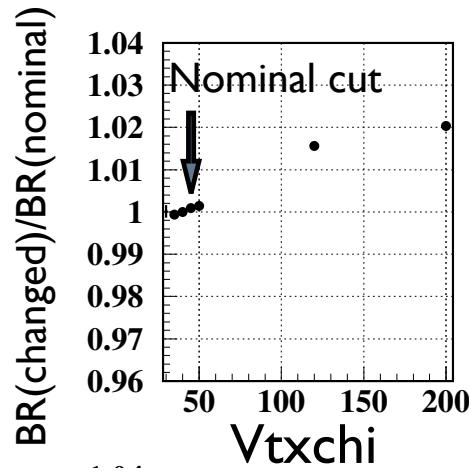
Radiative correction makes improvement but not enough



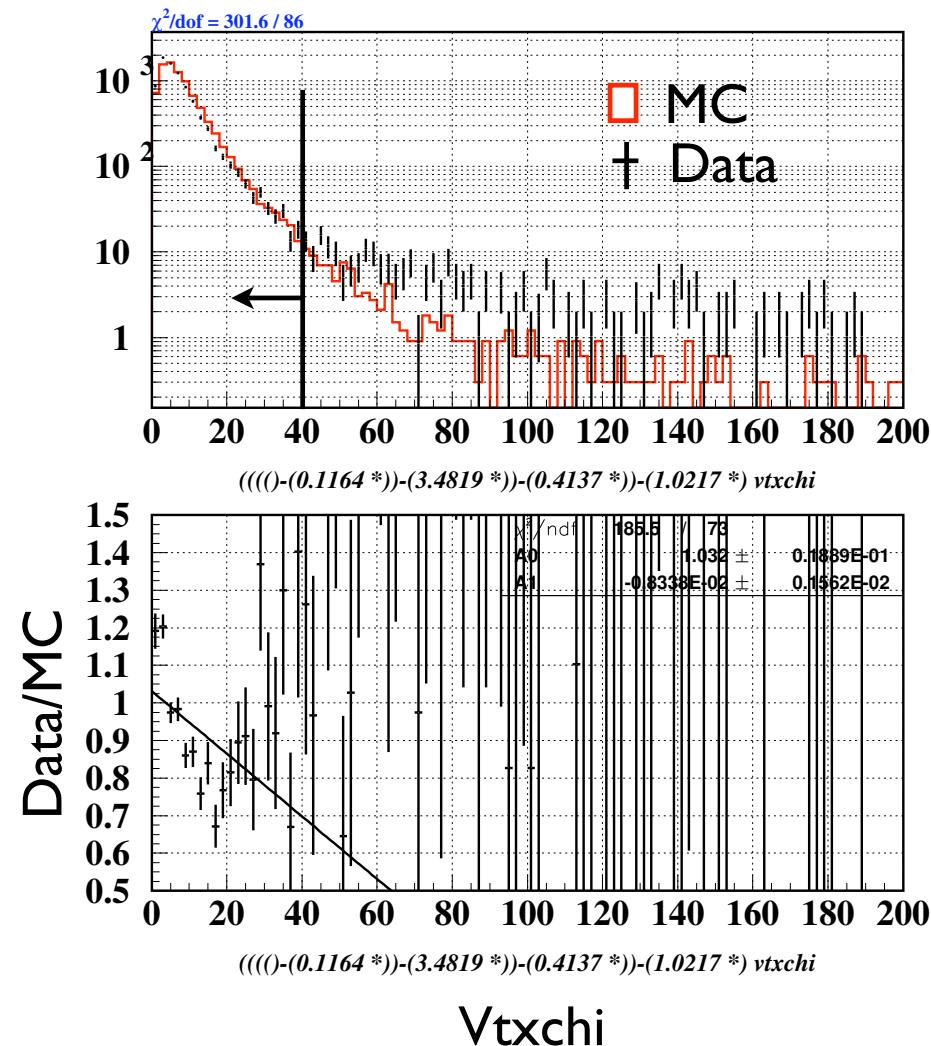
need weight for radiation ?

Cuts Variations

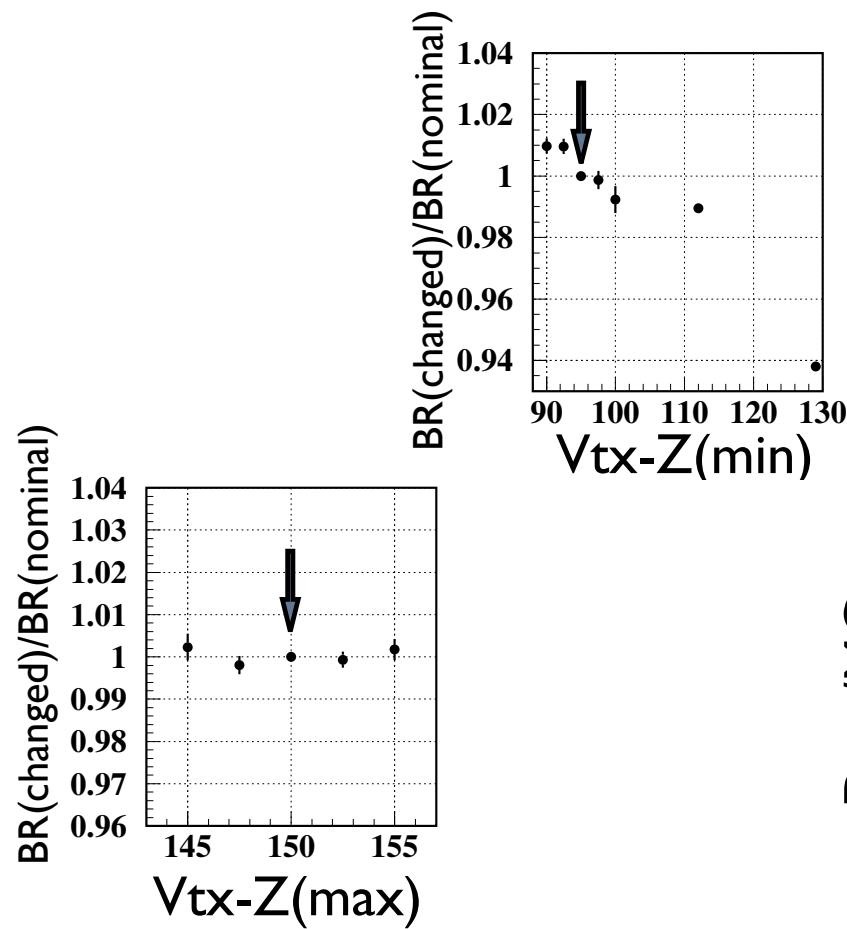
Variations of the measured Branching ratio with respect to change in cuts values



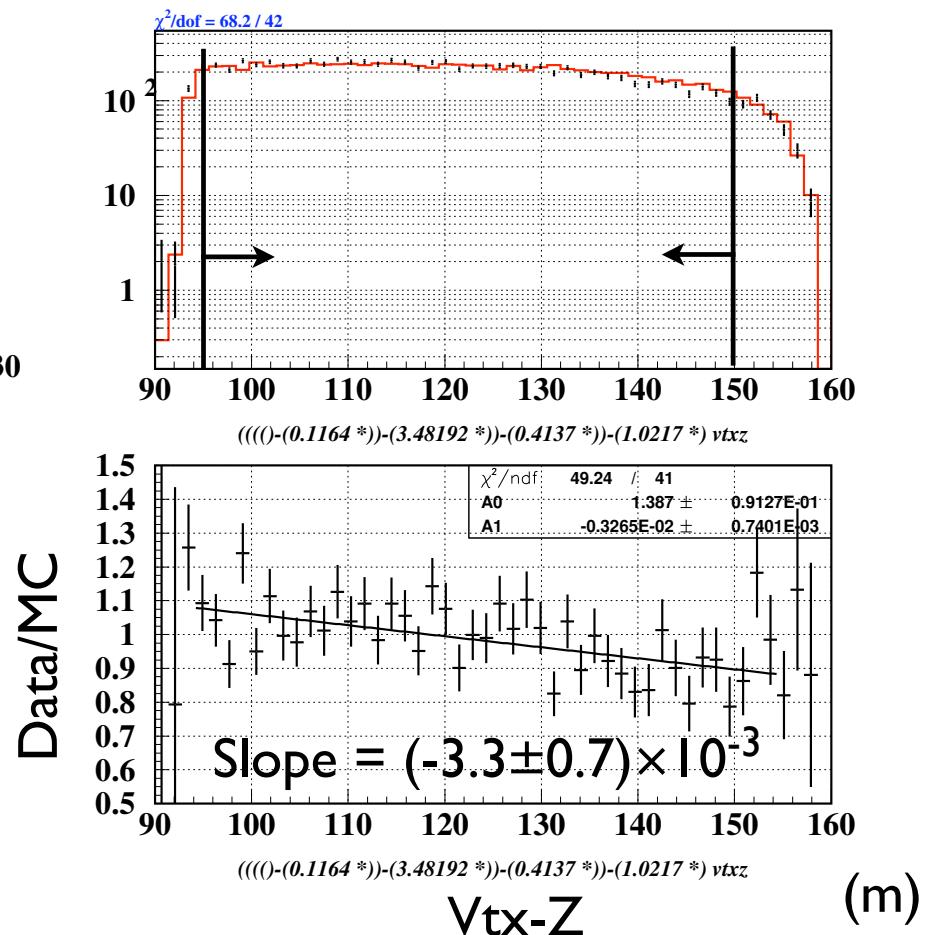
normalized to the nominal Branching ratio



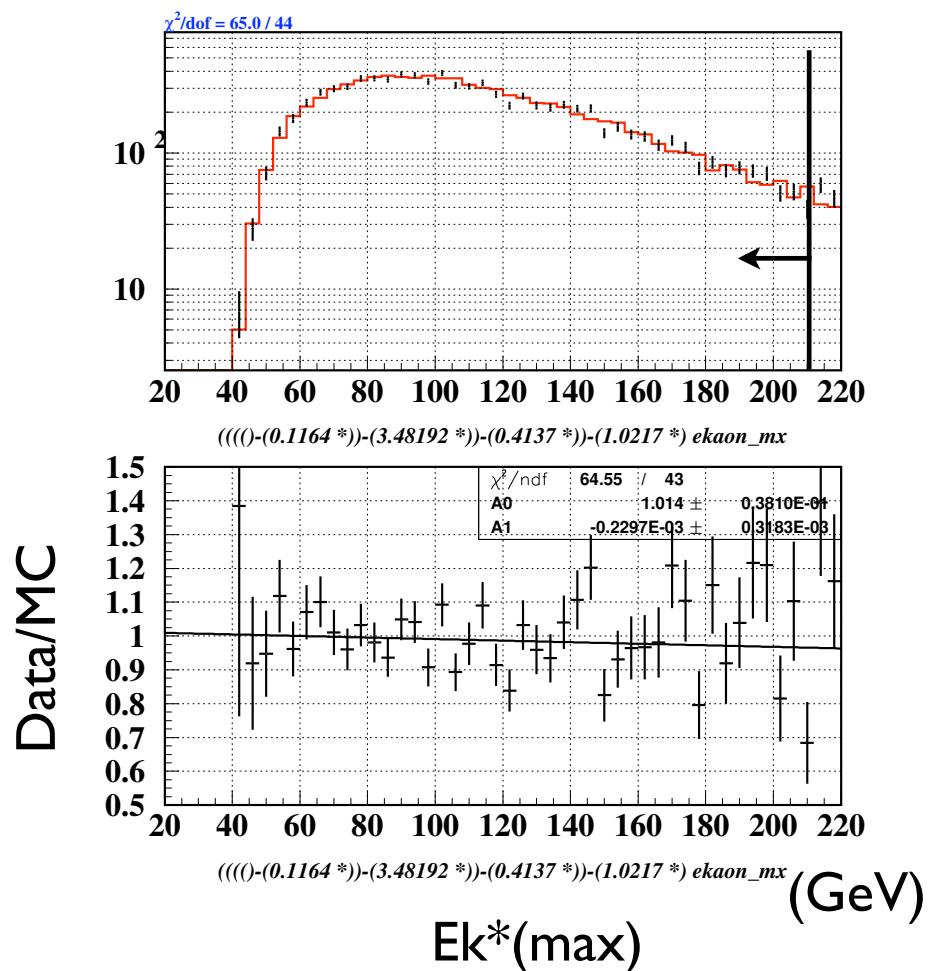
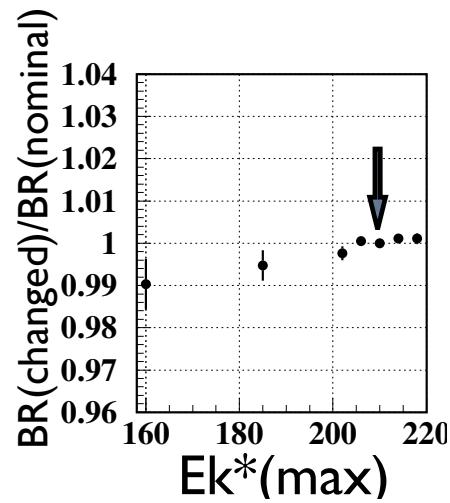
Variations of the measured Branching ratio with respect to change in cuts values



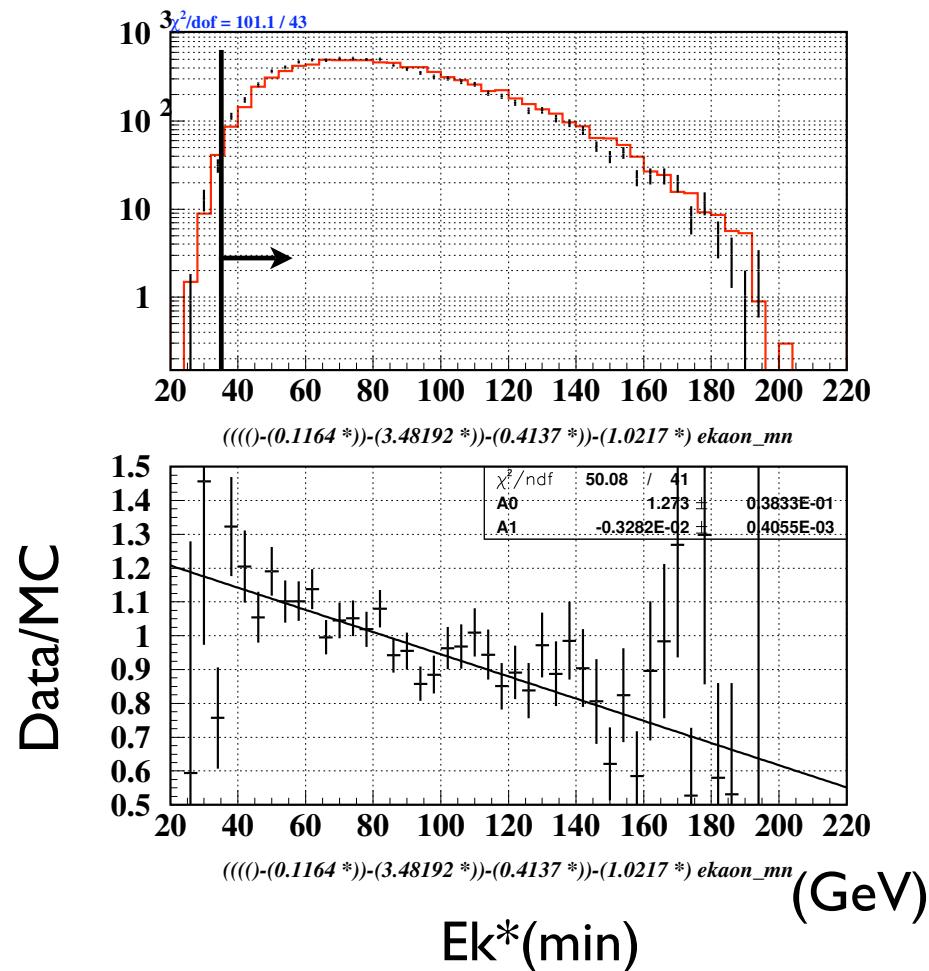
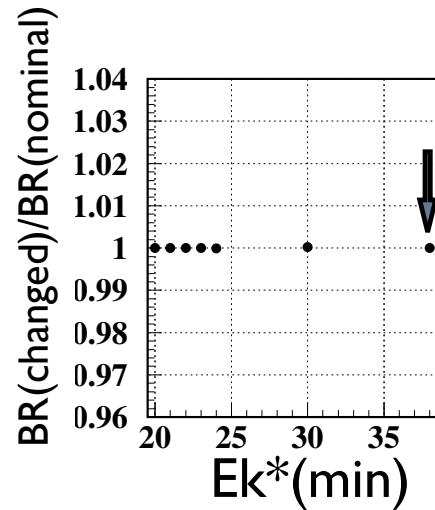
normalized to the nominal
Branchig ratio



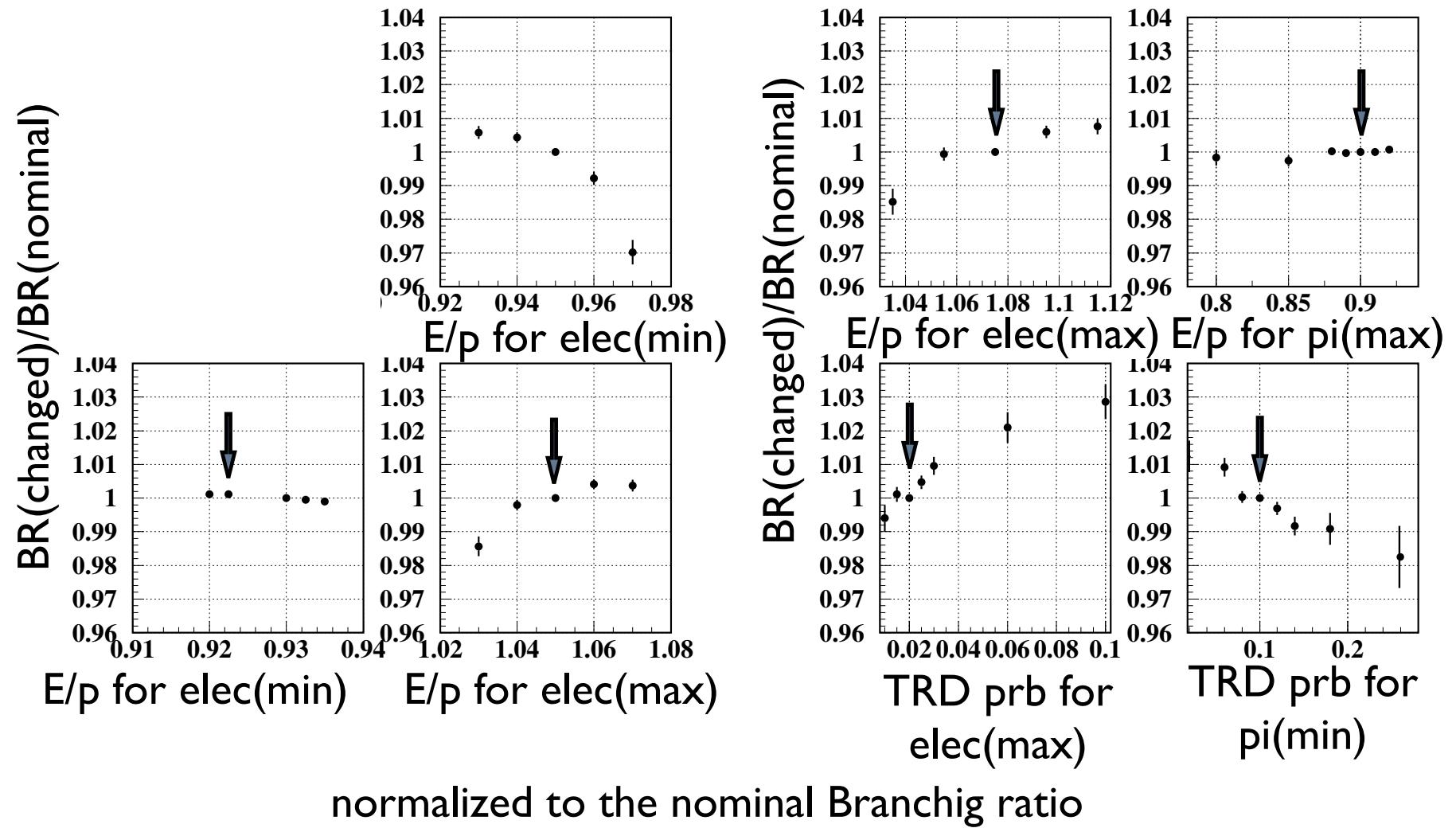
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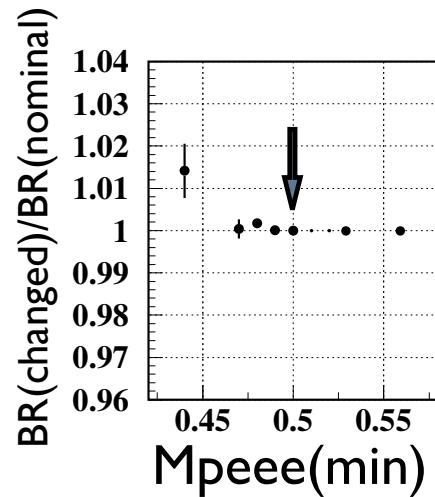
Variations of the measured Branching ratio with respect to change in cuts values



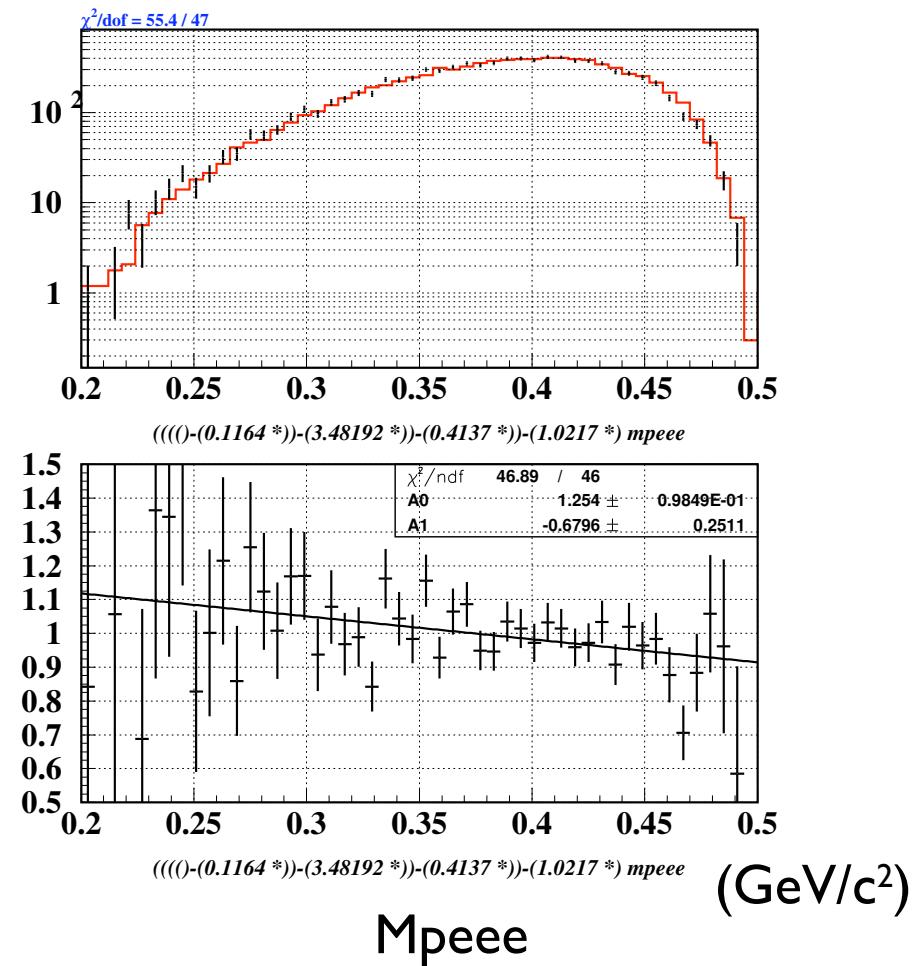
Variations of the measured Branching ratio with respect to change in cuts values



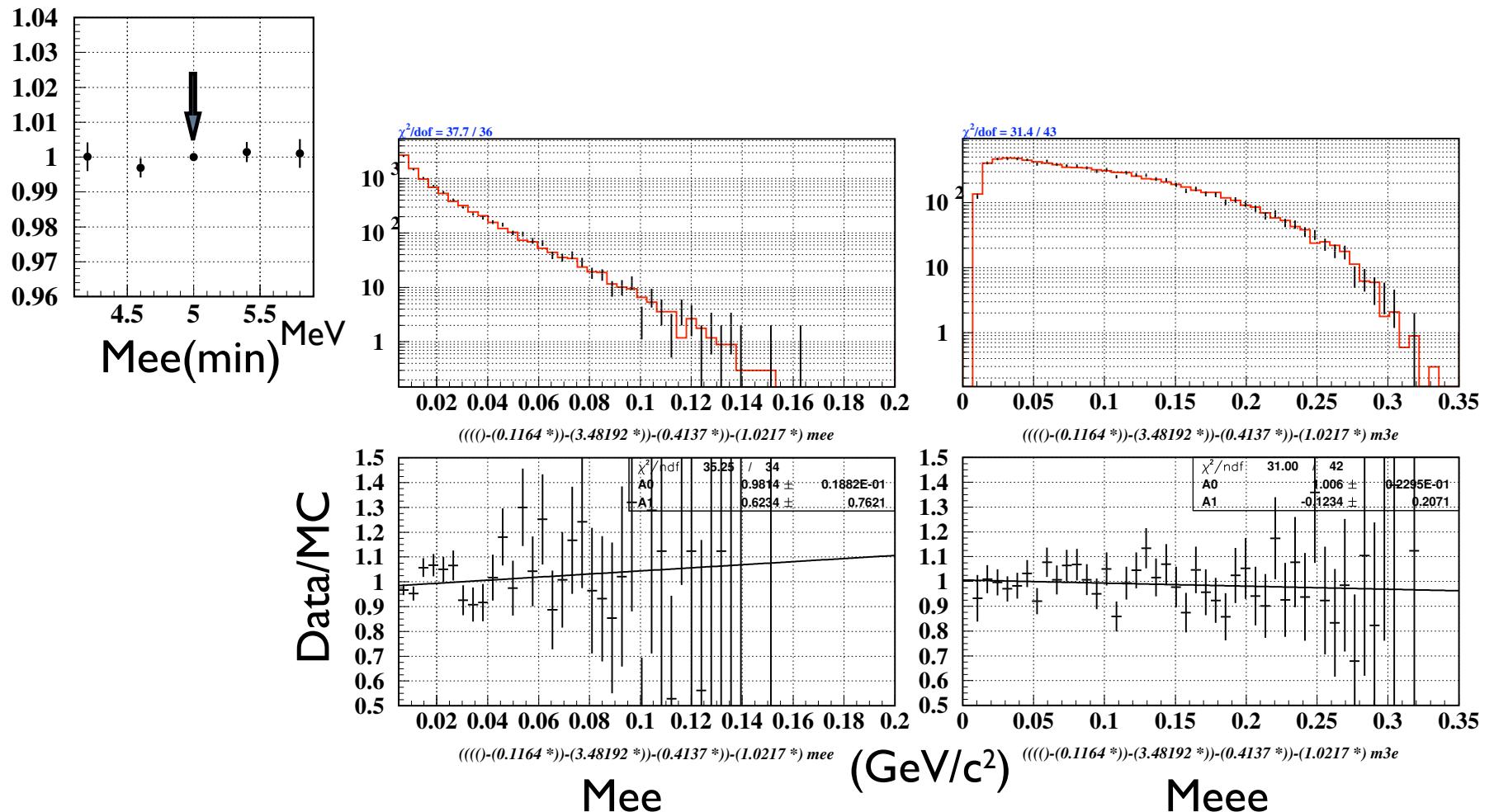
Variations of the measured Branching ratio with respect to change in cuts values



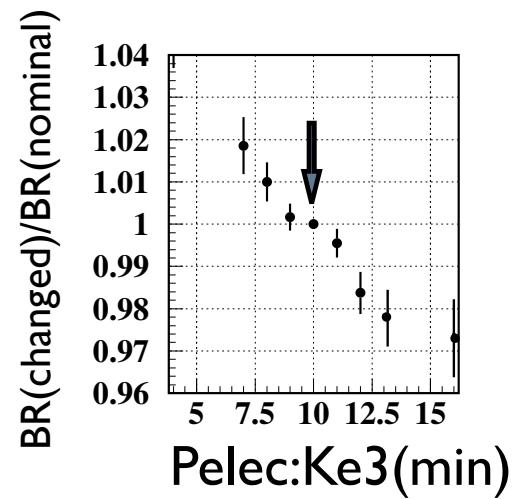
Data/MC



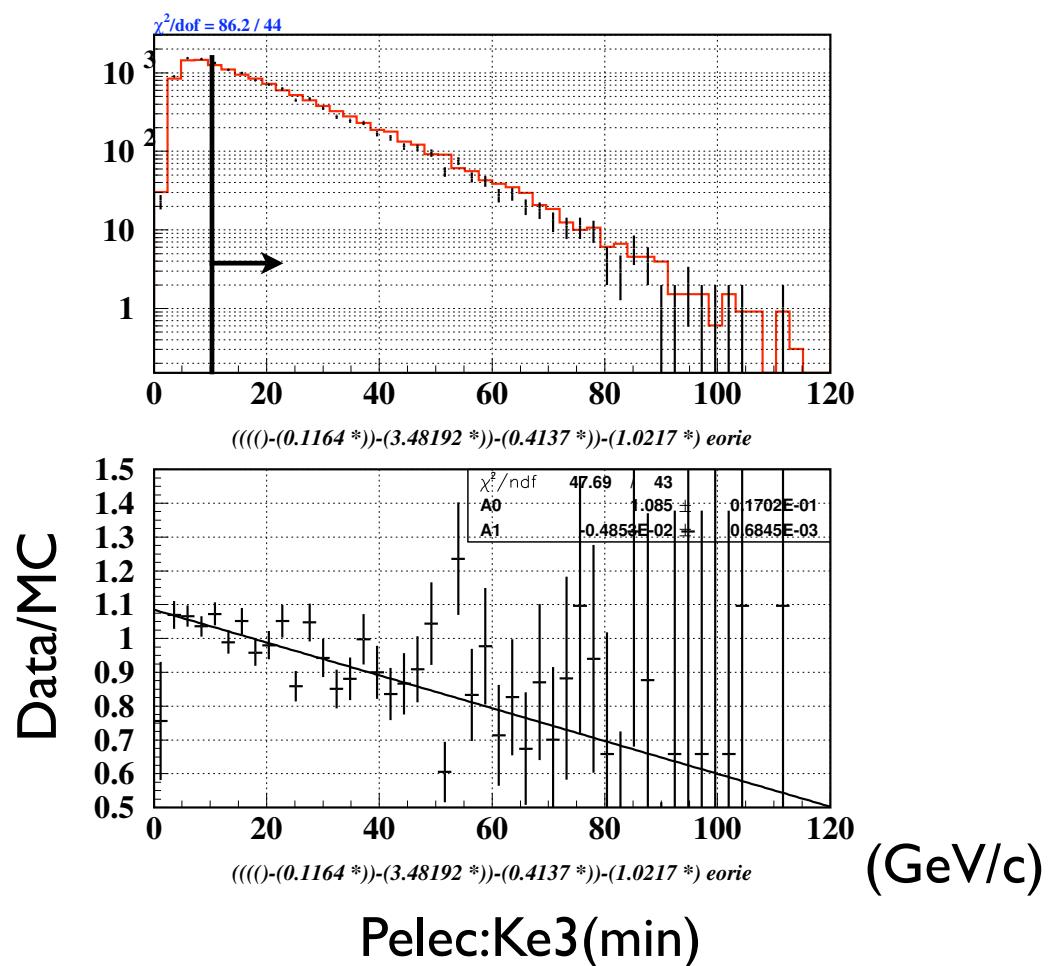
Variations of the measured Branching ratio with respect to change in cuts values



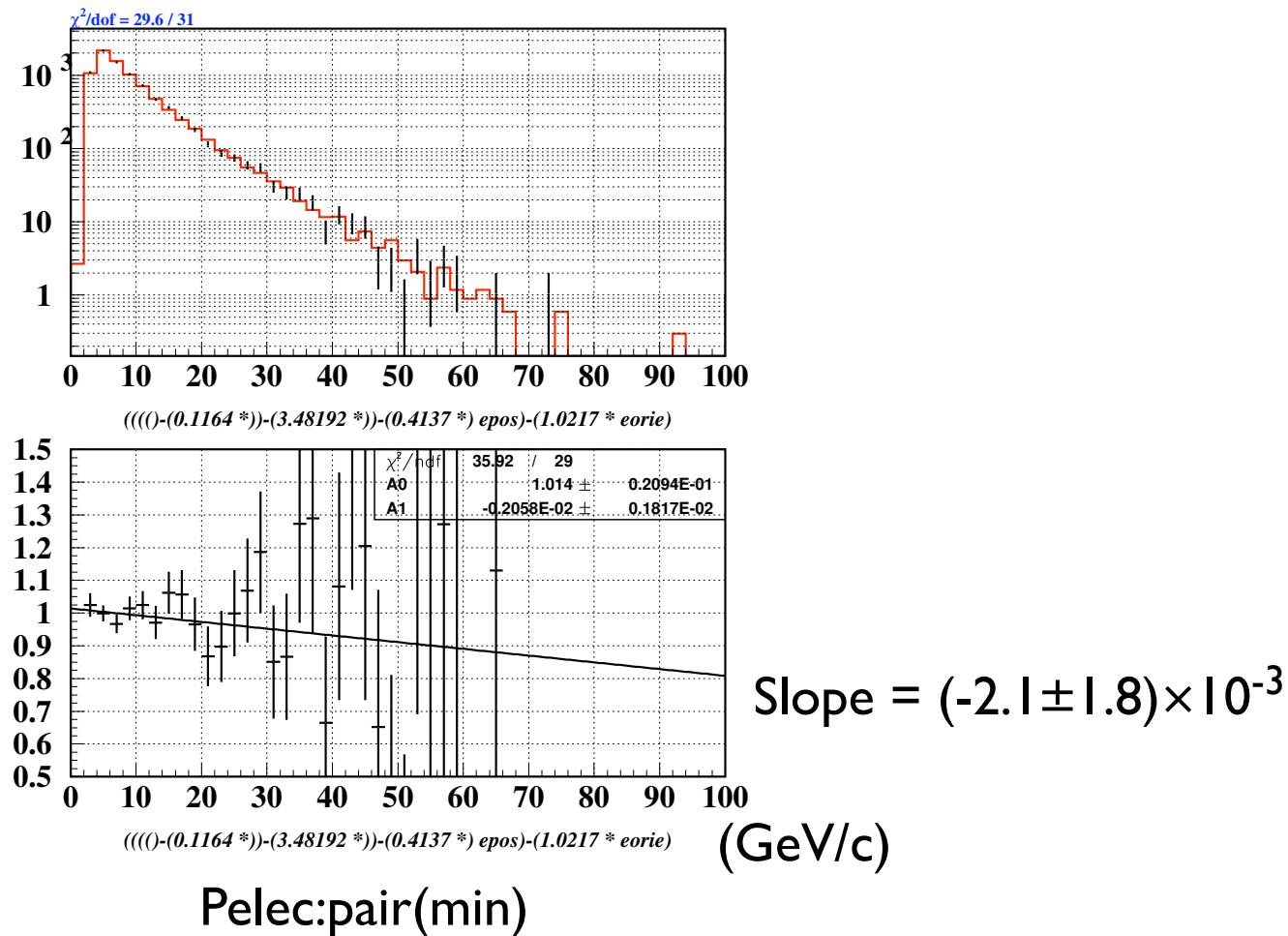
Variations of the measured Branching ratio with respect to change in cuts values



This is dominant source of uncertainty due to cuts variations



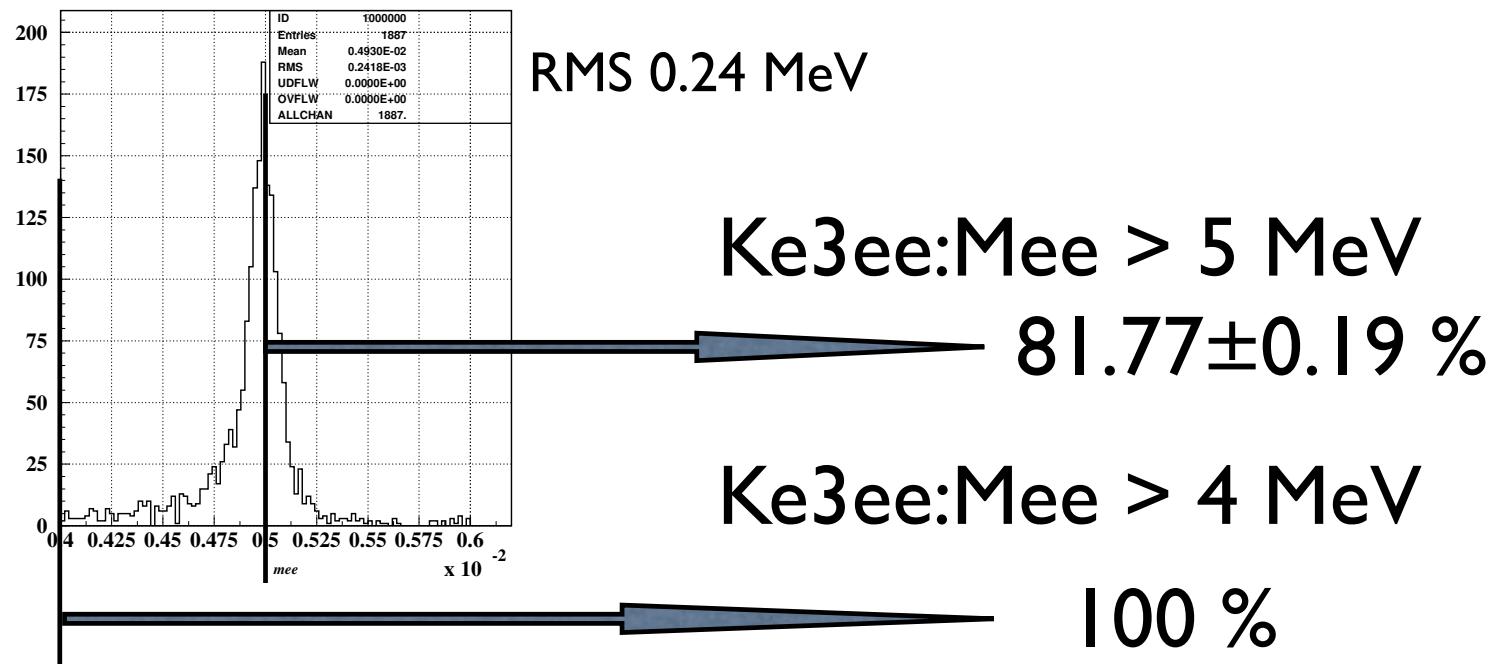
Momentum of electron from e+e- pair has good agreement between data and MC



Mee Cut-off on Signal Generation and Mee Cut on analysis

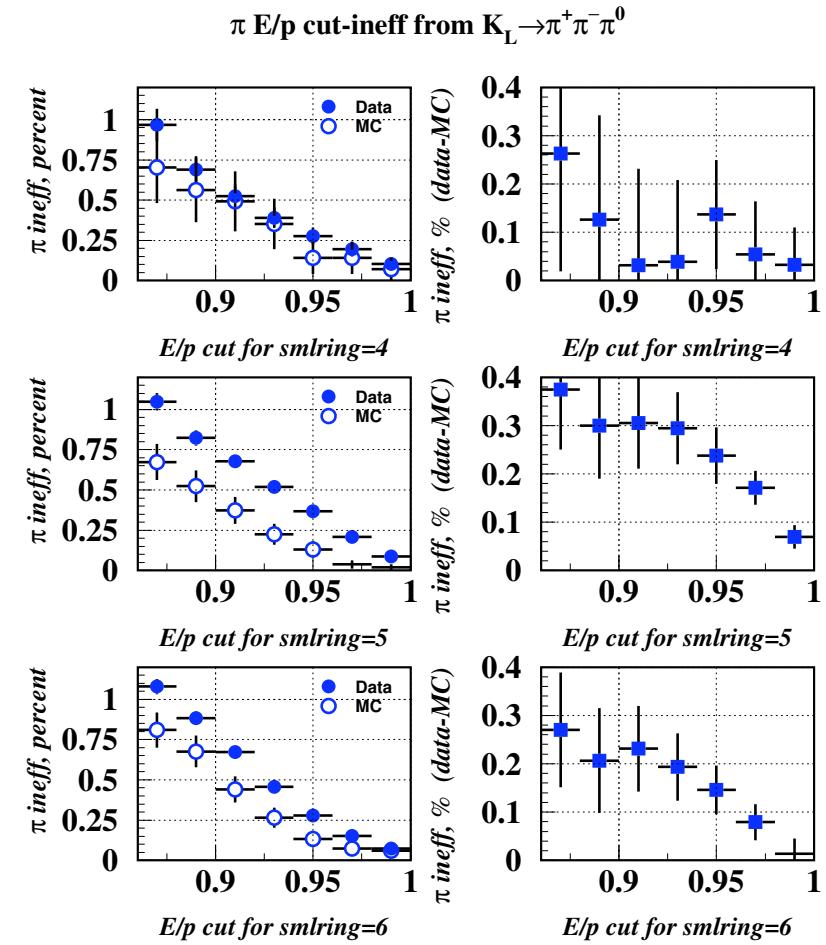
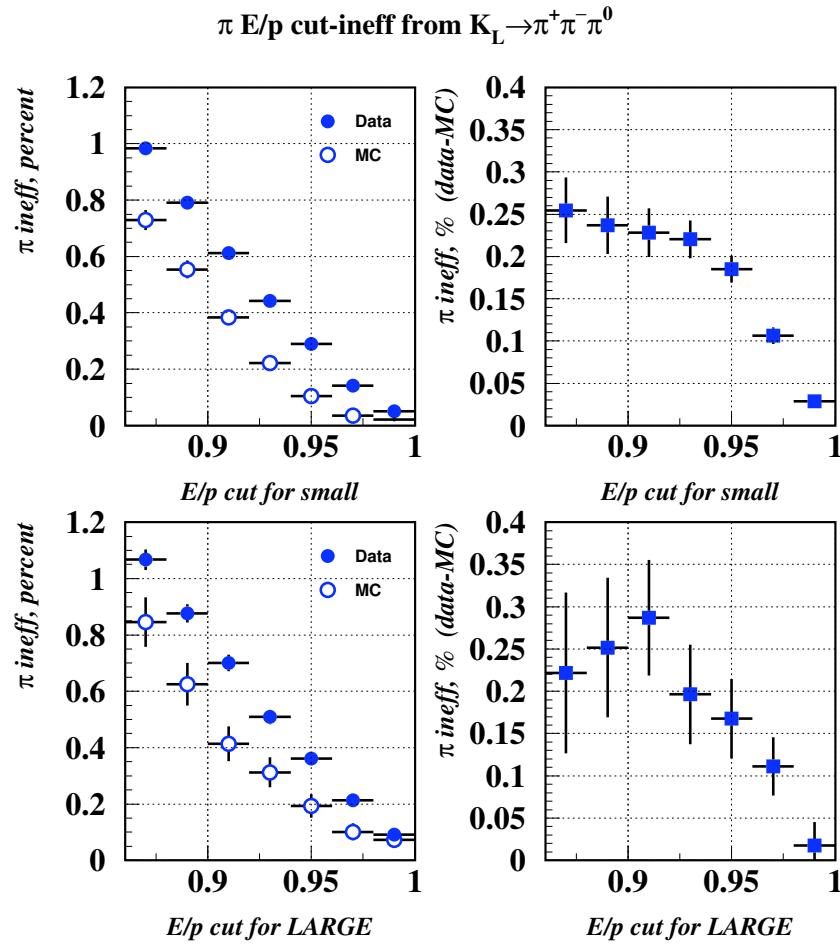
Final Branching ratio will have Mee cut-off value (5 MeV)

For finite Mee resolution of detector, we need to generate signal MC event from enough smaller Mee than 5 MeV



Uncertainty from this correction becomes 0.23% of Branching ratio

Data-MC Pi inefficiency Difference



Uncertainty from this correction becomes 0.04% of Branching ratio

Uncertainty due to radiative correction by PHOTOS

Without radiative correction

$$\text{BR(Ke3ee)} = (2.024 \pm 0.020) \times 10^{-5}$$

With radiative correction by PHOTOS

$$\text{BR(Ke3ee)} = (1.619 \pm 0.026) \times 10^{-5}$$

There is large difference by radiative correction.

Maximum uncertainty from this correction becomes 25% of Branching ratio.

Currently temporary uncertainties

Source of uncertainty	uncertainty(%)
Cut variations	4
Mee cut-off in MC	0.23
Data-MC Pion inefficiency Difference	0.04
Radiative correction	25

Most important next plan is study about how much reliable the radiative correction by PHOTOS

Conclusion

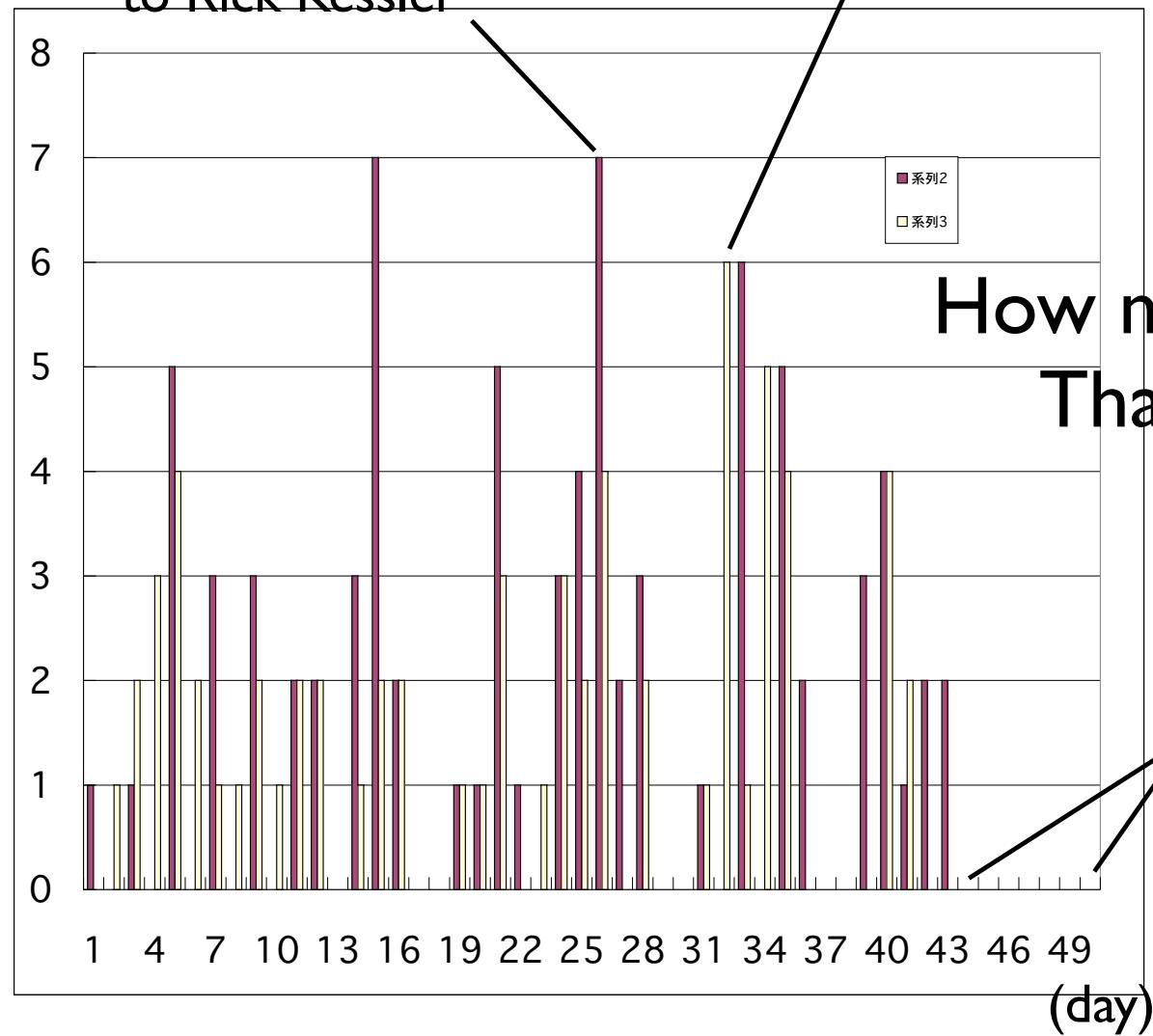
- Off-track in-time pair cut is effective to remove pmz-4e BG
- Radiative correction changes $\text{BR}(\text{ke3ee})$ 25%.
- Other uncertainties are not so large.

Plan

- To reduce uncertainties in radiative correction.
- To estimate systematic error due to other source.
- To estimate systematic error for normalization mode.
- Higher order MC for signal mode.

E-mail I asked questions
to Rick Kessler

E-mail he answered



How many E-mails !
Thanks Rick !

I grew up !